TRANSACTIONS

OF THE

AGRICULTURAL AND HORTICULTURAL SOCIETY

OF INDIA.

I.—*Report on the Physical Condition of the Assam Tea Plant, with reference to Geological Structure, Soils, and Climate. By* John M'Clelland, *Esq. Assistant Surgeon, Bengal Establishment, and Member of the Asiatic and Medical Societies of Calcutta.—Presented to the Agricultural Society of Calcutta, 8th February,* 1837, *by desire of the Right Honourable Lord* Auckland, *Governor General of India, &c. &c. &c.*

Part I.—*Geology.*

Crossing the numerous rivers from the Ganges to the Brahmaputra, at Jumalpore, we observed to the eastward an insulated tract of high land, between the towns of Moodapore and Pucculoe. It is laid down on the map of Bengal, as midway between Jumalpore and Dacca. This elevated tract, is, I have no doubt, an important geological feature; and I regretted that our duty did not allow of my remaining to examine it.

On approaching the Bramaputra near Jumalpore, I found the current had gradually forced its way through a yellow clay, or Kanka, that formerly controlled the course of the stream, directing it past the N.E. side of the high land above noticed. The aperture in the clay, however, which formed about twenty years ago, and is ever since progressively increasing, now allows three-fourths of the water of the Bramaputra to desert its former bed; and taking a new, or S.S.W. course, at a right angle to the old

one, it joins the Ganges at a place called Seraj-gunge. As the enlargement of the new course progressed, the old one became more obstructed by sands at its entrance, as in the annexed diagram. The sinking of a boat at *a*, giving rise to accelerated accumulations, so that during six months of the year direct communication between Jumalpore and Dacca, (by what is still laid down on the most recent maps of Bengal, as the great channel of the Bramaputra) is quite obstructed. In its former course, the river was crossed near Mymensing by a bed of red clay or Kanka, penetrating from beneath the alluvium, and extended in a narrow belt from the Colibaree hills, to the insulated high land just adverted to, forming a direct communication between these two points. Whether the change in this part of the Bramaputra which is now taking place, be owing to a degradation of the country in the direction of its new course, or to a progressive elevation of its ancient bed, is an interesting subject for enquiry. For my own part I am inclined to think the latter the real cause, from the fact of the principal obstruction having appeared to be situated at the yellow clay; the deposition of sand at the entrance of the old channel, would thus appear as a consequence of the diminished velocity of the current from such alteration in the levels of the fundamental rocks as are now taking place in that vicinity.

Approaching the Kossia mountains, I observed small insulated knolls projecting abruptly out of the low marshy plains by which they are surrounded. They are seen extending along the base of the mountains as far as the eye can reach, and proved to be the remains of a former talus, from the fact of the summits of some of them being composed of course pebbles and boulders.

The acclivity of the Kossia mountains facing these knolls, may, without any great inaccuracy be divided into three stages. The first a rugged, but gentle slope to the height of about 1500 feet; the second precipices, and the third a succession of summits. Extending along the top of the first stage, and at the base of

the second, I found the well marked remains of a raised beach, characterised by a deposite of marine shells, twenty-five species of which, I have indentified with an equal number of species comprised in a small collection of fossils from the Paris Basin, presented to the Asiatic Society of Bengal by Mr. Christie. The smallness of Mr. Christie's collection, consisting only of about 150 species, prevents me at present from establishing perhaps, a much more extensive agreement between the tertiary remains of these two remote localities.

Descending at another point, ten miles to the westward of this situation, I found at about the same altitude, a continuation of the line of organic remains; but the fossils were here grouped together in distinct families, as is observed to be the case in the subappennine deposites. I have procured sufficient materials from these beds to enable me to establish their nature, as soon as I am provided with the means of comparing them with the fossils of other tertiary groups which have been examined in Europe.

Without dwelling farther at present on the geology of the Kossia mountains, I shall merely observe that their agricultural character appears to improve much after crossing the valley of the Boga-pany. Previous to that, the surface being composed of horizontal strata, is barren, and without soil except in ravines; but at Muflong, where the rocks become inclined, a fine rich soil is abundantly retained on their surface, while the ravines afford an iron sand, in more than sufficient quantity for all the purposes for which the metal is required in the neighbouring country; but the ore is not found in sufficient quantity to render it an object of that importance, which it otherwise would be, in the vicinity of such extensive repositories of coal as here occur.

Should it be thought desirable to give the tea plant a trial in the Kossia mountains, I would recommend a situation at the western extremity of the valley of Myrung, where the soil is derived from a granular foliated felspar, very similar to the rock that affords some of those tea soils, which have been collected in China.

But for the circumstances of the raised beach, as well as of the discoveries of the late Mr. Scott, at the Colibarec hills, Assam

would present itself as an instance of a great valley of denudation. This would also be supposed to be the case, if the mountains on the two opposite sides possessed any characters in common. Porphyry, primitive limestone, serpentine, granite, and talcose slates, compose the mountains on the northern side of the valley, while tertiary sand stones, shell lime stone, and coal, compose the southern group; in conjunction with metamorphosed gneiss, green stone, and syenite.

Here then we have two distinct systems, with the valley of Assam interposed between them. The valley contracts towards its outlet, to a breadth of only twenty miles in Lower Assam; but in Upper Assam, its breadth is probably fifty miles. In Lower Assam the breadth of the valley is still farther contracted by a small system of hills given off from the mountains on the south; through these hills, the Bramaputra flows with a pretty uniform current, at the rate of about three miles an hour.

At Gowahatti the Mekeer hills, as they are called, are composed of metamorphosed gneiss, consisting of quartz injected into felspar from below, and containing beds of mica. In other places syenite, also containing veins and masses of quartz occurs; and at Goalpara, hornblende, containing concretions of felspar, constitute the rocks in the immediate vicinity of the river.

At Noagong the rocks composing a portion of the Mekeers, called Solano, are of a magnesian nature, including lenticular masses of the size of large boulders, of granular and compact quartz, and pebbles of various kinds imbedded in a fine, curved, slaty matrix, and the whole arranged so as to represent the figure of an irregular volcanic cone; near which, in the open plain, an insulated accumulation of granitic masses form a mound of twenty or thirty feet high. Whether these granitic masses were propelled from below, or projected from a volcano, I had no means of determining during my hasty visit to the spot; but they possess no common character with the other rocks in the vicinity, that I saw.

Without entering farther into particulars at present, I think it will be conceded, that Assam is not a valley of denudation, and that the mountains on either side not only belong to perfectly distinct epochs, but that Lower Assam has itself been

subject to very considerable disturbances, the effect of which has been to raise the general level of this part of the surface, by which means the waters in the interior were confined for a short time, until the accumulation of silt obliterated the depression within.

Upper Assam, as may be expected from these views, is an extensive alluvial basin; regarding which, much depends on the accuracy of our general and particular observations, as it brings us at once to the main object of enquiry—the history of the tea plant and the circumstances in regard to soil under which it exists. (See Plate I, Figs. 1 and 2.)

In considering the extent and nature of this basin, we are at once struck with the peculiarity of a perfect plain about eighty miles long, and forty broad, surrounded by lofty mountains and invaded by four enormous rivers, beside six or seven smaller ones, the least of which is as large as the greatest river in England.

These streams are so many great channels, by which nature conveys into the valley, the productions of the mountains; and it is only necessary to mention the direction from whence a few of the principal streams are derived, in order to be prepared to find, in the natural history of this romantic and singular spot, a greater variety of objects than a similar extent of any less peculiar situation could be expected to afford.

The first of these great rivers is the Dihong, which enters the valley by a narrow defile in the Abor mountains about twenty-five miles N.W. of Suddyah. Every circumstance seems combined to render the Dihong liable to sudden, or at least excessive periodical inundations, its hydrographical basin extending amidst snows, parallel to the equator from the 82° to the 98° of longitude, along the elevated plateau of the Himalaya.*

The first rise of this river takes place in the beginning of March, and amounts to about 15 feet, said to be occasioned by the melt-

* According to Malte Brun the peculiarity of the inundations of the Nile depends on its course being extended from east to west within the tropics. The inundations of such rivers are higher but less sudden than those of rivers running parallel to the meridian like the Suban-Shieree. See pages 6 and 7.

ing of the snow. Towards the middle of April, there is a general subsidence of about ten feet, and the river retains something more than its ordinary level, until the periodical rains set in, when the inundations commence, the river then begins to rise at Gowahatti, where it attains in July and August a height of 40 feet above its level during the dry season.

The second great branch of the Bramaputra—the Dibong, enters the valley by a similar defile to that of the Dihong. Between the defiles of these two rivers, which are not above fifteen miles apart, there is a remarkably abrupt and picturesque mountain, terminating in three peaks, on the highest of which snow lies for two thirds of the year. The source of the Dibong is unknown, but it must approach, if it does not pass within, the mountains on the frontier of China. It forms the natural boundary between the Abor, and the Mishmee tribes.

The third branch of the Bramaputra, is that which retains the name of the great river, from its falling straight into the axis of the main trunk, from the opposite, or eastern extremity of Assam. It enters the valley by a series of cascades, it is said, rather than by a deep defile : and indeed this peculiarity is distinguished at a distance of thirty miles, by the accumulations of rolled stones which have been propelled forward, causing a succession of rapids which gradually increase in number and difficulty. This river, after its entrance into the valley, receives the Digaroo and Kondul rivers from the Mishmee mountains on the north, and the Noa Dihing and Tenga from the south-east. For reasons to be afterwards assigned, it will be well to keep the direction of the two last named rivers in view.

The fourth great branch of the Bramaputra, called Suban-Shieree, takes its origin, it is supposed, in Thibet; and enters Assam from the north, below the junction of the other great branches, and at right angles with the great fluviatile trunk. From its southerly direction, and the peculiarity of its source in the snows of an elevated chain, from which it descends transversely, the inundations of this river take possession of Assam, previous to those of the other rivers. The silt which its floods convey into the valley, (where they spread and lose their im-

petuosity) is consequently deposited so as to impede the course of the Bramaputra. The great stream is thus caused to diverge from its direct course, and from time to time to force its way, by the bursting of new channels. Between two of these at present, an island, sixty miles long and ten broad, is formed at the confluence of the Suban-Shieree, chiefly by its silt.

It has now been shewn that Upper Assam is an alluvial basin, formed by the confluence of various great rivers, which flowing from opposite directions, meet in its centre. I have been unable to determine whether the original surface underwent any subsidence of its former levels, or whether the elevation of the rocks in Lower Assam was the only cause of the production of the basin. The total absence of any rocky protrusions through the alluvium, and the general levels relatively, between Upper and Lower Assam, as well as Bengal, being only such as to afford an ordinary current of about two miles or three an hour, indicate a depression of the older rocks in Upper Assam. More extensive observations, and experiments in boring, can alone determine this point.

The lowest deposite is a reddish yellow clay which lies in contact with the rocky masses in Lower Assam, forming the surface of that part of the country, but a short distance above Bishenath; this clay dips beneath the alluvial deposites and is seen no more.

The following deposites then succeed from below upwards; first, fine clays; second, sandy clay containing gravel; and thirdly, sand and gravel. These sedimentary deposites indicate in regard to motion three conditions of the water from which they were derived.

1. Stagnation;
2. Slow but general movement;
3. Active currents:

a series of effects, in every way illustrative of the interruption of the Bramaputra in Lower Assam, from the causes already described. A brief description of each deposite will now be necessary.

All rocky protrusions from beneath the soil, as well as the red

clay which forms the surface of Lower Assam, disappear about twenty or thirty miles above Bishenath, and from a hilly, or what in other countries would be called a mountainous character, the surface becomes uniformly flat. The first change of structure that becomes apparent is in the red sandy clay, becoming intermixed in streaks with a white or light yellow plastic clay; similar to what is found at Jumalpore, on the northern side of Bengal, reposing also on the red clay of that district. In both situations I found this clay perforated by small empty cavities from which the stems of monocotyledonous plants have been removed by decomposition.

To this a blue plastic clay succeeds, and both are seen in contact in the bed of the Bramaputra opposite to Joorhath, where the blue clay is used for the manufacture of coarse pottery; after being burned it becomes white, indicating the vegetable nature of its colouring matter, and the absence of iron. I searched as diligently as I could, but without success, to discover the character of its fossil contents.

The third deposite consists of sand and light coloured clays, alternating; and is either clay, sand, gravel or boulders, according to the peculiar influence of currents in the waters from which it was derived. It is this deposite that determines as far as soils are concerned, the peculiar character of vegetation in Upper Assam, and it is therefore entitled to careful notice in this report.

In the northern side of the basin, *i. e.* in the direction of the defiles of the Dihòng and Dibong, I have had no opportunity of making enquiries; but from analogy I suspect the finer sands and clays are more rare in this, than in the opposite side of the basin, and from the circumstance recorded in Captain Wilcox's report, (*Asiat. Res.* vol. xvii.) of both those great rivers being navigable to canoes for some distance within the mountains, we have no reason to expect either a gravelly or a clayey soil in this direction, but rather, an uniform sandy structure mixed with vegetable matter.

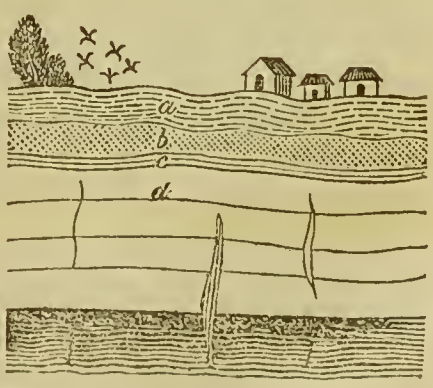
On the eastern side of the valley the case is different, and, as already observed, the impetus with which the third great branch of the Bramaputra falls from the mountains, has propelled to the

distance of thirty miles within the valley, an extended talus of boulders. With these exceptions there is a pretty general uniformity in the deposites of sand and clay, especially in the south side of the valley. I shall therefore only attempt a general systematic description, and even this will not be found to apply exactly to every situation.

A bed of gravel more or less deep reposes immediately on the surface of the blue clay. This is succeeded by sand, from fifteen to thirty feet deep, according to the place in which it may be examined. The lower portion of the sand is coarse, becoming gradually finer as it ascends in the bed, and passing into a yellow but light clay.

This clay, from the absence of plastic qualities, is easily distinguished from the yellow plastic clay which reposes beneath the blue clay. It is from five to fifteen feet deep in different situations, and is generally succeeded by a deposite of fine yellow sand which usually lies beneath the soil, or sometimes mixed with decomposed leaves, forms the surface.

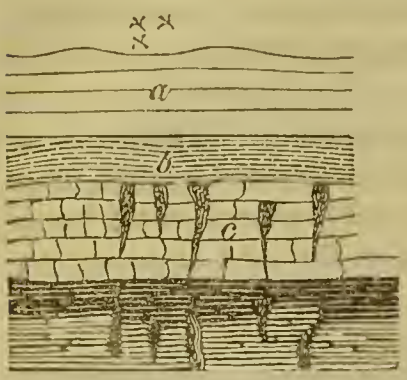
From this series there are the following deviations. Instead of a single bed of yellow clay, there are sometimes several smaller ones; alternating with sand. The sand beneath the yellow clay sometimes assumes the solid form of sand stone, and in many instances this change has more or less completely taken place.



At Rangagora, on the Debru river, the following section is exposed in the bank of the stream. *a* (in the annexed figure) is the superficial deposite, 8 feet deep; *b* is the river sand, coarse and cleanly washed; *c* is a thin layer of tenaceous clay, the last from 2 to 5 feet deep; *d*, yellow sand 15 feet deep, containing small nodules of oxide of iron, pebbles of quartz and felspar.

On the Noa Dihing river, about ten miles from its junction

with the Bramaputra, the banks present the sand converted into stone, of sufficient consistence to resist, in bold rocky precipices and promontories, the encroachments of the stream. *a* (in the annexed figure) is the upper portion of the bank, composed of sand and clay, ten feet deep; *b*, bed of coarse sand, undergoing consolidation from below upwards; *c*, a deposite of sand altered into stone. One of the mountains on the southern side of the valley, at Gubru-purbut (Plate IV. Fig. 2,) which we ascended to the height of about 1000 feet, presented low branching hills, extended from its base into the alluvial basin, composed of consolidated sand, similar to that on the banks of the Noa Dihing; and containing fossil trees *(Coniferæ)* at the height of 300 above the valley, and similar in their nature to the recent trees, now carried down from the Mishme and Abor mountains during floods and deposited in the sands; so that it may be a just inference to suppose that the sand stone composing the base of the mountain alluded to, was formed in the lower levels of the valley, precisely as that on the Noa Dihing is now forming; and when consolidated sufficiently to bear the shock, raised to its present position. It rests upon slate-clay, passing into limestone of marine origin; which rocks have been also uplifted with the former from below.



The last section of the sand, which I shall notice, is exposed by the Maun-moo river, in the vicinity of the tea colony of Nigroo (Plate II.) The first stratum from the surface, is composed of yellow sandy clay, covered with light sandy soil, next below is sand containing quartzose and other pebbles. The sand increases in coarseness, and cohereney, the lower it is observed in the bed; and the lower portion reposing on the blue clay, is so completely consolidated as to require considerable force to break it with the hammer. One continued spring is seen extending along the lowest layer of sand, where unable to percolate through the blue clay, the water is retained in contact with the sand repos-

ing on the latter; to which it communicates a portion of the carbonate of iron which I found by analysis it contains, and which it derives from particles of the oxide of that metal in the sand. When the lower stratum of sand becomes perfectly consolidated and loses its porosity, superincumbent layers in succession are then exposed to the same influence. Nor are these changes less interesting when considered with reference to the tea plant and agriculture in general, than they are to geology.

The superficial yellow clay, already adverted to, presents to the naked eye minute white grains imbedded in a matrix of brittle clay; but under the microscope, the whole appears to be composed of sand. It is incapable of being rolled or moulded into shapes, and is finer or coarser, according to the place in which it is found, but its most important peculiarity consists in allowing water to percolate through its texture, and descend into the deep bed of sand beneath.

Superficial sand. This reposes on the last described clay, and under the soil. It may be supposed to be the effect of local currents, but it is often found in situations to which local inundations could not reach: as for instance at Rangagora, and in lower places this sandy deposite is often either carried away, or covered by a stratum of mud. Although this sand is usually pale yellow, or grey coloured, yet it changes greatly in this respect, and where it abounds in iron, and the subjacent stratum at the same time, is sufficiently impervious to cause a due proportion of moisture to be retained, so as to operate uniformly on the particles of metal; the colour of the sand, as well as of the substratum is red: more rarely the same colour is communicated also to the soil.

The description I have gone into regarding the structure of Upper Assam, will enable us the better to enter upon the consideration of soils; but first it is necessary to make a remark on the nature of certain changes to which the surface is exposed.

The rivers as they fall into the valley, precipitate such portion of their contents as their waters from diminished velocity are unable to convey further. This has occasioned a succession of low rounded sand hills, which are particularly to be observed on the south eastern side of Assam, at the tea localities of Cuju, and

Nigroo where from the rapidity with which the Noa Dihing and Bora Dihing, fall into the valley, such accumulations are most to be expected.

There is consequently a general inclination of the surface, in this direction, extending from the main fluviatile trunk, to the foot of the mountains. Along this descent, the Debru, Bora Dihing and Disung rivers flow in very indolent currents from the S.E. where they take their rise, except the first, in the Naga mountains. If we add to these rivers a small stream which rises in a southerly direction, in the same mountains near Gubru-purbut, we have an accurate definition of the limits of the tea plant in Upper Assam.

Cuju, one of the places in which we found the tea plant, is situated at the source of the Debru; Tingrai, another tea locality, is on the bank of one of its tributaries; and Noadwar, a third situation at which we found the plant, is in a tract subject to the inundations of the same river; and we heard of its existence at Cherrabie, in still closer connexion with this stream.

At the source of one of the tributaries of the Bora Dihing, we examined the tea plant near the village of Nigroo; and heard of its existence at the extreme branch of that river, in hills twenty miles south-east of Nigroo.*

We have also positive information of the existence of the plant, at Borhath, near the foot of the Naga mountains, and close to the source of the Disung; but circumstances prevented our visiting either of the three last mentioned places.†

Of the different streams just noticed, whose banks afford localities of the tea plant, the Debru, if not the most interesting, is at least the one with which we are best acquainted. It rises in the sand hills, or undulating country between the Bora Dihing, and Noa Dihing rivers, and derives its first waters from springs situated between the sand and clay deposites. The stream is languid, and not such as to indicate any great difference of level

* The colony of plants alluded to is situated at Namroop; many of our attendants had been there and saw the plant.

† For the situation of these tea colonies, see Plate I.

throughout its course, which is about sixty miles in a N. W. direction, but its banks near its source are from twenty to thirty feet high, and the surrounding country is dry; while the very reverse obtains in the middle of its course, and from thence to its confluence with the Bramaputra.

It passes through some of the best rice countries in Upper Assam, although the sandy nature of the soil would not impress an agriculturist with very favourable notions of its suitability for the cultivation of this grain.

The best grounds for rice, are those in which the yellow clay approaches the surface; but where this is not the case, the loose soil is submitted to a process of irrigation, by which its texture is quite altered. This is done by levelling, and exposing the new surface to submersion, either once or repeatedly, for a longer or a shorter time, according to the degree of alteration to be effected. The treading of cattle, and of the labourers employed in the occupation, and the decomposition of vegetables, tend to alter the character of the new soil, and to render it compact and impervious.

Those spots which form the centre of undulations too high to be levelled, or submersed, form convenient sites for villages, and for the growth of opium—the second, and almost the only other object of cultivation.

I observed in this district, that where there is a sufficient command of water, which is generally the case, the driest, and most sandy surfaces may be converted into rice ground, either by causing a deposite of mud upon the surface, where the depth of sand is great, or by the infiltration of the finer particles of loosened soil, which are held in suspension, until deposited, or retained, by the sandy soils through which the waters are allowed to percolate.

Ascending the Bramaputra, I observed many instances of the rapidity with which wastes, composed entirely of sand, newly washed forward by the current during floods, become converted into rich pasture; and this too, independent of any subjacent impervious structure. As the freshes begin to lessen, and retire into deeper channels, the currents form natural embankments

on their edges, preventing the return of a small portion of water, which is thus left extended over the sands. These last already saturated, have little capacity for more fluid; that on the surface remains stagnant; and exposed to the action of a tropical sun, slowly evaporates, leaving a thin impervious crust of animal and vegetable matter. This impregnated with the seeds of *Saccharum spontaneum*, and other grasses, that have been partly transmitted by the winds, and partly left behind by the waters, derives sufficient moisture from the mists and dews so prevalent along the Bramaputra during the nights and mornings, to form a non-conducting medium sufficient to protect the germs from the scorching heat to which they would be otherwise exposed in the naked sand. Numerous flocks of aquatic birds frequent such places for fish, and molluscs, on which they feed; and as vegetation begins to appear, herds of elephants and wild buffaloes are attracted by the plentiful supply of food, and the retirement such places afford; and contribute to manure and form the new soil.

During the few excursions we made into the interior, I found other transformations of the original surface of the country, referrible to artificial, rather than to natural causes: such for instance as extensive embankments, raised as fortifications in remote times, when the resources and population of the country must have been in a far different state from what they are in at present. But the remains, in Upper Assam, of such works as are here alluded to, have an interest of another description in this enquiry, distinct from what they would afford to the antiquary.

When we find those artificial embankments, or tumuli, extending for miles through the most deserted tracts of Assam, raised often to the height of 20 or 30 feet above the plain, and overgrown with ancient forest trees, as large as those amidst which the colonies of wild tea plants are found, the question is at once suggested—"May not these colonies of wild tea plants, have been cultivated gardens, into which the plant was introduced artificially?" A doubt would be thus cast at once upon the indigenous nature of the tea plant, and though it may have since propagated and grown spontaneously for ages, yet the chances

against its successful cultivation for commercial purposes would perhaps in consequence be increased.

Farther arguments might be adduced in support of this view, by referring to the antiquities of Assam; which are both extensive and decisive as to the former existence of such a state of society in regard to refinement, as would lead us to conclude that the luxuries of neighbouring countries, (and the tea plant among the rest) were probably artificially introduced.*

On the other hand, it may be observed in favour of the indigenous nature of the plant, in Upper Assam, that it is not found beyond the bounds of the alluvial basin ; so that we must ascribe to the latter, some natural influence to which we are indebted for the possession of this plant; as such restriction appears to me to be dependant only on natural causes, which do not alone affect this species, but also various others in both kingdoms of organic nature in like manner.

On reference to the map it will be seen that the plant is traced along the course of the small rivers which enter the valley from the south-east, in a series of distinct colonies; rendering it probable that the seeds have been transmitted forward along the course of the currents. It is not necessary that the seeds should have been conveyed at once down the current of any one of these streams from a great distance into the valley, or to suppose that their vegetative principle could survive submersion in a current for any length of time without injury. It

*At Teespore, near Bishenath, on an eminence by the river side, the surface to the extent of an acre is covered with architraves, cornices, pilasters, columns, and all the essential parts of a splendid building, carved in granite. The ornaments present a mixture of Saracenic and Roman styles. The stones do not agree in their nature with any of the rocks in the vicinity ; and from the way in which they are strewed, as well as from the freshness of their angles, would never appear to have been used. Temples of Hindoos are numerous, and about Gowahatti, some of them are very extensive and more elegant than I had previously seen in any part of India. Those that excel most in every respect are the most ancient, and are built of granite. Many of the insulated hills in Lower Assam have their masses sculptured in situ representing gigantic figures in bas-relief; and as such monuments are referred to Buddhists of early date, they prove, that the masses on which they have been marked, have undergone no general change in very recent times, although they do present some signs of the disturbing influence of earthquakes, which are said to be here frequent and severe.

is enough, that a single seed may have fallen from a Chinese caravan, near the source of one of those fluviatile ramifications which converge to the valley, on every side, over 18° Long. and 4° Lat., where it may have been deposited under circumstances favourable to its growth and propagation. A colony would thus be established, from which thousands of seeds might be annually transmitted, and although ten thousand of these might be lost, still one of them might be drifted during a flood along the banks of a stream, and deposited under circumstances favourable to the establishment of an advanced colony, and so on.

This view of the way in which the tea plant performed its migrations into Assam is not merely theoretical, as it occurred first from facts which were presented to me, during an examination of the tea colony at Tingrai, as will be afterwards shewn.

The next object is, to inquire whether we have any proof of the direction from whence the plant has been conveyed into the valley. It is necessary to call to mind that Assam is divided from east to west, by the Bramaputra; and that in the northern section of the valley thus formed, no tea colonies have hitherto been found, hence the plant would not appear to have been introduced from countries in that direction;* nor did Mr. Griffith find any trace of it in the Mishmee mountains, or even that the Mishmee tribes have any knowledge of it whatever.† On the other hand, a Kamtee of rank, named Chi-long-fu, residing at Suddya, informed the Deputation that in all those countries to the eastward of Assam, tea is used at meals instead of water, and that during the hot season, it is the only drink of those who can afford to procure it—that it is drank at meals by people in good circumstances, and that the poor have it only at feasts, because they cannot procure it at other times. He also informed us, that it is by the common people of those countries with which he himself is connected, the general offering made to great men on visits of ceremony, when compliments are intended to be paid. It is cultivated, he says, in gardens; and plantations are reserved

* See Plate I. † Letter to the Tea Committee.

for the purpose of procuring it, and that the expense is equal to about one anna for two pounds weight. When preparing it for use this quantity is placed at once in a large vessel from which individuals of the party help themselves.

He farther assured us, that the tea thus universally used, is identically the same as the wild plant now growing in Assam, and that it is prepared by all the nations east of Suddya, with which he is acquainted, just in the way that it is now prepared by the Singphos, whom it was then supposed we were about to visit.

He said it was cultivated in gardens and plantations for convenience, and for the purpose of keeping up a sufficient supply, rather than from an idea of improving its quality beyond that of the wild tea plant. In their plantations, he informed us, they did not interfere with the growth of the tree, farther than by depriving it of the leaves for which it is cultivated. It consequently attains such a size as to oblige those who collect the leaves to climb upon the branches.

This is the substance of the information we derived from a person of weight, and some political influence at Suddya; but whether it is of much value in the elucidation of the question of the cultivation and manufacture of the Assam tea plant, I shall not at present venture an opinion: but this information, and certain physical indications regarding the direction from whence the plant originally approached the valley, are mutually in confirmation of each other. Thus we have still an extreme eastern depôt of plants at Namroop, the source of the Bora Dihing river. From this, Nigroo may have been directly supplied; but Cuju, as it presents the largest plants, I suspect to be the oldest colony of which we have any description, in the valley; and situated at the source of the Debru river, it is certainly the parent of all those colonies which have been discovered along the banks of that stream.

Part II.—*Topography, Structure, and Soils of the Tea Colonies.*

The village of Cuju is situated about twelve miles from the banks of the Noa Dihing river, and twenty miles south of Suddya, in the midst of an extensive forest. It may be approached either by penetrating on elephants directly through the forest from Suddya, or by boats, as far as a spot on the banks of the Noa Dihing, called Cuju gât, from which a foot-path extends through the forest to the village. About half way there is a small settlement of Singphos, consisting of a few families, scarcely numerous enough to justify the term village being applied to their habitations. In their neighbourhood is a patch of ground a little lower than the adjoining forest, appropriated to the cultivation of rice. With this exception the forest is totally uninterrupted from the river to Cuju, where the rice grounds of that village extend over a space of about fifty acres, some two or three feet below the level of the general surface.

2. The soil of the rice field is in places rich, but superficial, reposing on a grey sandy clay; but generally it is itself grey and clayey. The soil in the forest is however light yellow, and of more sandy consistence than that of the rice grounds, but still of a somewhat clayey texture. We crossed a small stream, the water of which was coloured with what proved on analysis to be oxide of iron. The bed of the stream being sand, we may expect the same process of consolidation to be going on here, as has already been observed in regard to the Noa Dihing.*

The site of the village of Cuju, though surrounded by extensive forests, and scarcely elevated above the common level, is drier than any place I had previously seen in Upper Assam. The soil in the village, unlike that of the district generally, is of a rich brown colour, and affords good crops of opium.

3. The day after our arrival at Cuju, we set out to inspect the colony of tea plants, the first we had ever seen. We descended, soon after leaving the village, into a small depression,

* See page 10.

Tea Colony at Cujoo Village

which had been cultivated for rice; proceeding about half a mile beyond this, we entered a thick forest, intersected by a small and nearly stagnant stream, the souree of the Debru. The ground was somewhat more sandy, than that of the general surface which we had passed over. Pursuing a foot-path that had been recently formed, we came upon low sandy undulations, connected with the former windings of the stream we had just crossed. The sand in places was thrown up into mounds, the highest of which could not be more than twenty feet. After leaving these banks of sand, we had occasion to cross the stream again; we then entered upon level ground, the soil dark and firm under the feet, covered with grass and a few scattered trees. This was of short extent, as we suddenly entered the forest again and were surrounded by tea plants.

4. The first remarkable thing that presented itself here, was the peculiar irregularity of the surface; which in places was excavated into natural trenches, and in other situations raised into rounded accumulations at the roots, and trunks of trees, and clumps of bamboos, as in the annexed figure.* The excavations seemed as if they had been formed artificially, and were from two, to three, and even four feet deep, of very irregular shapes, and seldom communicating with each other. After many conjectures, I found the size of the excavations bear exact proportion to the size and height of the nearest adjoining trees, and that they never appeared immediately under the shade of large branches. The cause then appeared to be the collection of rain on the foliage of lofty trees; from which the water so collected is precipitated in heavy volumes on the loose and light soil, excavating it in the manner described.

5. The trenches are from one yard to ten in length, and generally a yard, or two yards wide; and their general figures correspond to the form of the interstices between the branches above. The tea plants are most numerous along the margins of these natural excavations, as well on the accumulations of dry soil

* In which the branches of the common trees are supposed to be removed in order to show the Tea plants.

raised around the roots of bamboos. The soil is perfectly loose, and sinks under the feet with a certain degree of elasticity derived from dense meshes of succulent fibres, prolonged in every direction from various roots. Its colour is light grey, perfectly dry and dusty, although the surrounding country was still wet, from the effects of rain that had fallen for several days immediately prior to our visit.

6. Even the trenches were dry, and from their not communicating with each other, it seemed quite evident, that the soil and substratum must be highly porous, and different in this respect from the structure of the surrounding surface of the country.

Extending examinations farther, I found the peculiar character of the soil in regard to colour, consistency, and inequality of surface disappear, with the tea plant itself, beyond the extent of a circular space of about 300 yards in diameter.

7. It was also to be remarked here as well as in other situations in which the tea plant was afterwards examined, that insulated individuals were smaller in size, the farther they were found detached from the natural limits of the colony; which last were always found to be marked by certain changes in the soil, except perhaps in a single instance.* No. 978 is a specimen of the soil in which the tea plants were most abundant. No. 982 is that of the common soil of the district taken about 500 yards beyond the boundary of the colony.†

8. We now continued our journey along a path extending through the forest in the direction of W.S.W., occasionally approaching the banks of the Debru river. The soil in the forest, is similar to that already mentioned. Animals are very few, and consist chiefly of wild elephants; the forest indeed is too damp and shaded to afford a suitable shelter to the animals of Lower Assam, and of the plains of India; and the elephant is perhaps the only creature among the larger animals, who could procure sustenance in such a place. A new species of squir-

* I here allude to the western boundary of the upper colony of plants at Tingrai. See page 28.

† For analyses of these soils, see page 29.

rel, (larger than *Sciurus maximus*) which I have named *S. bengmoricus*, seems to be peculiar to this tract. Towards the close of the first day's journey, we crossed a small clear stream running into the Debru on our right; and indicating an elevation of the surface towards the east.

9. We spent the night in a Singpho village called Cujudoo, and the following day we continued our journey through the forest in a southerly direction. Our path for perhaps five miles, extended along a massive embankment, probably thirty feet high, and overgrown with some of the most ancient trees in the forest. From this we pursued an easterly direction, and after descending from the tumulus, found a tree fern, which I believe proved to be of the same species as that which had been previously found at Cherra-punji. The surface soon became more elevated, and undulating; but still composed of yellow sandy clay. The streams then descended in an opposite, or N. E. direction, running we were told into a river called the Maun; while those we crossed in the early part of the day, run S.W. into the Debru, proving that we had crossed a tract of forest, elevated perhaps about 50 feet above the general plain, with a gradual, or almost imperceptible ascent, and descent, on each side, indicated only by the direction of the rivulets. We then crossed the bed of a small stream of clear water, passing over pipe clay; from thence the white, or yellow sandy clay, over which we had passed ever since we entered the forests, disappeared as well as all undulations; the surface assuming the ordinary character of flatness, to which we had been accustomed, and was chiefly composed of clayey soil, sometimes blue and in places yellow, but without sandy admixture. These appearances continued for a few miles, until we entered the village of Nigroo, on the banks of the Bora Dihing river. From thence we entered the bed of a small river which joins the Bora Dihing, called at this place the Maun-moo,* and proceeding up its bed, for the distance of about three miles, reached the second tea colony.

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* *Moo*, or *Mokh*, mouth; synonymous with *Moon*, in Bengalee.

10. Nigroo.—The soils in which the plant is here found, are of three sorts, each of which differ from that in which it was found to grow at Cuju, but presenting points still more instructive and interesting than the latter colony afforded. The topography of the place, presents to our notice; First, the dry sandy bed of an occasional pond that empties itself by means of a deep drain (said to have been formed by nature, though it looks artificial,) extending across the colony of plants, and communicating with the bed of the Maun-moo. Secondly, a mound of tolerably rich, but very light soil, extending in a north easterly direction, and presenting a serpentine declivity to the S.E.

11. The Maun-moo river partly encircles the spot, giving it the shape of a small peninsula.* The level of the river is about 15 feet lower than the surface at the foot of the hillock, or mound, so that during floods the tea plants in the latter situation, must be liable occasionally, (I should think,) to slight inundation.

12. Approaching the spot, from the river, we crossed a zone of almost pure sand, overgrown with reeds, and in the course of a few paces, reached a sandy clayey soil in which we found a few small tea plants; a few steps farther introduced us to a drier, and less consistent soil, in which the plants were found larger, and more numerous. (I selected a specimen of each of these soils, marking the first, 1009; and the second, 1010.) Surrounded by tea plants, we ascended the mound, the soil of which is light, fine, and of yellow colour, having no sandy character. Here the plants were found still more numerous than in the lower ground.

13. I selected a specimen marked 1013, from the roots of various plants on the summit of the mound. I then descended and took a specimen (1011) from the roots of a large plant at the bottom of the mound; the two soils appeared to be quite different. We then traced the plants along the summit of the mound for about fifty yards, when they disappeared where the soil became dark. Now descending to the foot of the mound,

* See Plate II.

I found the tea plant there disappear, where the soil instead of being sandy or clayey, became rich and stiff, towards the bed of the pond; the last two specimens were numbered 1017, and 1018, consecutively.

14. On crossing the mound towards the N. W. the ground continued high to the river, which is not more than fifty paces distant; but the plants disappeared within twenty yards of the S.E. brow, the soil becoming grey and sandy—a fact which first suggested the idea, that where the drainage is more powerful on the summit of an elevation, the plant requires a different soil from that in which it flourishes in low ground, a view which subsequent observation, and analyses, tended rather to strengthen.*

15. Noadwar.—The third tea colony we visited, is near the village of Noadwar, in the centre of Upper Assam, and not above twenty-five, or thirty miles from the Bramaputra.

Proceeding to the spot where the plants are found, we passed over rice grounds which were almost quite under water from the torrents of rain then falling, in the middle of February. Having entered the skirts of a forest which, though not under water, was wet and slippery, and in some places deeply covered with mud; we suddenly ascended from the dry bed of an occasional water course,† and at first sight discovered a total change of soil and vegetation.

From floundering in mud, we now stood on a light, red, dry, and dusty soil, (1176) notwithstanding the rain to which it was exposed, in common with every part of the country at the time.

16. This colony is probably about fifty yards in length and twenty in breadth, and extends along the S.W. brow of the dry channel: the height of the bank on which the tea grows is about five feet. The surrounding low ground is overgrown

* See XVI.

† Water courses, or what are called Beels, are common features in this part of the country, and are formed by the inundations of the Bramaputra, which, retiring rapidly, have excavated shallow channels in the alluvium to the depth of three or four feet, where the superficial yellow clay interrupts their farther progress. When not too low, they form good rice ground and pasture.

with reeds, and the higher tracts with forest trees. The surface on which the tea plants are growing is much indented, and excavated; for being loose, it is easily encroached upon, by accumulations of water when they take place in the channels. Thus situated on a loose and defenceless bank at the verge of a forest, this colony of tea plants may be considered as undergoing gradual obliteration from destruction of the surface, and there is reason to suppose that it has at one time been much more extensive than it is at present.*

17. The colour of the surface is dark yellowish brown, but on being opened it appears much brighter, and on sinking to the depth of three feet, it changes progressively to a deep, pure, orange-coloured sand, quite distinct from any of the other soils, or subsoils in this part of the district; and in this remarkable situation the tea plants are so numerous, that they constitute a third part, probably, of the entire vegetation of the spot. The red soil disappears gradually within the limit occupied by the tea plants. I observed the level of the waters in the wells in this neighbourhood, to be about ten feet below the surface of the ground.

18. Gubru-Purbut.—The fourth colony of tea plants we visited, is three days' journey E.S.E. of Joorhath, where the plant is found in a bright yellow, or red soil, on the lower extremity of a small range of gradually declining hills, extended about three miles from the Naga Mountains into the valley. The extent of ground which is covered by this group of plants, is about 60 yards in diameter, and of circular shape. The spot is raised about fifty feet above the plain, which is low, marshy, and covered with reeds on the northern and eastern side; but the low ground on the S.W., where a small valley is formed between the hill and the mountains, is cultivated with rice, and contains several villages; but at the immediate foot of the eminence on which the tea plants are situated, the ground is too low and subject to inundation, to admit of any sort of cultivation, so that this locality of the plant may be said to be surrounded by

* See Plate III.

inundated grounds on all sides except on the S.E., where the narrow chain of hills covered with forest, connects it with the Naga mountains.*

19. The general soil of this district is grey, and sandy, of clayey consistence; but the inner valley, which lies between the tea hill and the mountains, is generally covered with a rich brown soil, except in the rice fields, where its character is altered by irrigation. The soil in which these tea plants grow, is heavier and more compact than the tea soil of Noadwar; but in other respects it is much the same, and like that soil it is perfectly different and distinct from any other soils composing the surface in the neighbourhood. Extending from the centre towards the boundaries of the colony, the soil loses its peculiarities, and on the northern boundary becomes clayey, where the plant disappears. On the south it assumes a more sandy character, is loose and excavated by numerous small pits; the plant becoming stunted, gradually disappears where this change in the soil has taken place: thus indicating that this structure of soil, though exactly suited to the plant in the plain, as at Cuju, is not adapted to it on a hill.

20. On the eastern boundary, where the surface descends gradually towards the plain, and is perfectly loose and rather sandy, the plant grows luxuriantly. An excavation here, proved that the thin yellow soil degenerates beneath, into a pale greyish yellow sand; but in the centre of the colony, where the plants are crowded equally on every side, the colour of the soil brightens, on being opened, as it does at Noadwar, and changing from reddish yellow to the purest orange, it becomes more loose, as well as rougher when rubbed between the fingers the lower the excavation is made; characters which correspond exactly with the subsoil of Noadwar, the only difference being, that the surface is here consistent, and somewhat hard, while at Noadwar it is loose, although a variation in the state of the weather, may in some measure account for such differences.

21. Tingrai.—Tingrai, the fourth colony of tea plants we visited in Assam, (though I have here placed it fifth and last,) is

* See Plate IV.

calculated to afford some interesting observations regarding the natural history of this plant.*

The first peculiarity to be observed in the topography of the spot, is a small stagnant river formed in blue clay, about twenty or twenty-five feet below the general level of the plain, on the southern side of the stream, (if we may venture so to call it, under the view of its being stagnant only in dry weather,) where the tea plants are found; but the opposite side is a low delta covered with reeds.

22. The series of deposites composing the high bank on which the tea plants grow, is,

First, reddish yellow clay, four feet deep; denuded of its former soil by floods of surface water, which during heavy rains descend to the river. These waters have now however sunk a proper channel in the clay, which prevents their spreading during rains as formerly: but at the time of our visit the channel was perfectly dry.

Second, a deposite of coarse river sand, four feet deep, and similar to that described as forming a part of the section of the Debru.

Third, a bed of tenaceous clay, sometimes white, at others black, but generally slate coloured—two feet deep.

Fourth, a bed of yellow sand descending beneath the water in a perpendicular bank, partially consolidated, so as to appear like friable sandstone—an appearance however which is more conspicuous beyond the limit of the tea plants, than beneath the place they occupy.

The tea plants in the first of the foregoing series, are crowded together to the brink of the bank, as well as on every slight projection from the face of the precipice over the water, calculated to give them support; while the distance they extend towards the interior, is about thirty yards from the margin of the river. When raised by the spade, the soil in which they grow separates into loosely aggregated, clayey concretions, of reddish yellow colour, rather hard and dry.

23. Pursuing the channel which has been already mentioned,

* See Plate V.

(as grooved into the surface in which the plants are found, by the repeated action of currents from the interior during rain,) in the direction of its source for about a quarter of a mile, no tea plants appeared on either side beyond the distance of thirty yards from the river. Advancing a little more than a quarter of a mile, the channel begins to spread into numerous reticulated branches, with little intervening islets formed of naked sand and dry rubbish around clumps of bamboos, and trees that have taken such strong root as to resist the degradation of the surface, collecting these heaps from the waters during floods. Occasional small tea plants here begin to make their appearance, mounted upon these accumulations.

Proceeding farther, the tea plants became more numerous, and the number of the channels in the surface more multiplied, each however smaller, and the whole spread over a greater space, until we gradually found ourselves in another colony of tea plants, distinct from the former one.

Extending our enquiries up the course of the various channels, we found them all emanate from one; but beyond the point at which this separates in the manner described, I could not find a single tea plant.

24. The boundary of this colony, like that of the lower one, is abrupt and defined at that portion which is presented to the direction of the current; while the lower extremity presents a lingering train of straggling individuals extended along the direction of the stream, thus proving the migration of the plant in the course of the currents, from the upper to the lower colony.

Suspecting from these interesting facts, that both colonies were supplied from some more permanent and extensive location of tea plants, I pursued the extreme channel in the direction of its source; and in doing so, found that several smaller channels entered it from the S. E., indicating a gentle ascent of the surface in this direction, from whence probably the tea seeds were directed forward from some original depôt, to the places just examined.* Having proceeded about a mile into the interior

* The discovery of an additional colony of tea plants in this vicinity since it was visited by the deputation rather strengthens this view.

of the forest, I found my attendants who were boatmen, and not much accustomed to expose themselves, where the foot prints of tigers were so numerous, had thought it most prudent to return, and on finding myself alone, I followed their example without accomplishing the object in view.

25. The point at which we entered the forest of Tingrai, was not of itself calculated to afford a just prepossession as to the circumstances of the tea plant; for the first individuals we saw, presented themselves to us in a dark soil, but this ultimately proved to be but the western limit of the colony. In the same direction too, the forest had been cleared for cultivation, and imagination readily conceived it to have been covered by tea plants, an assumption for which neither the facts elicited during the examination of the place, nor those derived from previous enquiry, afforded any good reason to suppose correct. At the same time, the number of young plants we found in this soil, affords an encouraging instance of the disposition of the plant, to accommodate itself to any soil, as far at least as its vegetative powers are concerned. But crossing from this point, in order to determine the lateral extent of the colony, the illusion was exposed, and the plants were found to increase in size, and number, as we approached the light sandy soil composing the islets between the reticulated channels; disappearing again in a dark, rich, moist, soil, which formed a well defined limit to the colony on the eastern side of the channelled surface.

26. These observations apply merely to the upper colony; the lower one is distinguished from it by an interval of half a mile in which the plants are totally absent, and by a still greater interval in which a few delicate individuals are seen, whose seeds have been carried from the upper colony, thus far towards the lower one, by the currents of waters, as is evident from their growing in the accumulations of sand and drifted rubbish which form the irregular surface between the dry channels already mentioned. (23.)

27. The plants in the lower colony, grow in the yellow denuded clay already noticed, (22), but to which the office of a soil is communicated, by its peculiar position on the verge of a

steep high bank, and by its reposing on a deep bed of sand; two circumstances which render it dry and porous. Nodules composed of an earthy admixture with oxide of iron, were found plentifully in the dry channels, not uniformly distributed, but accumulated in places. Although the general colour of the soil composing the islets was grey; yet in places it presented a bright red appearance, either from the large proportion in which oxide of iron exists in those places, or from the different degree of oxidation to which it has been exposed.

Chemical Examination of the Assam Tea Soils.

No. 978. Soil from the roots of the tea plant at Cuju. Colour light grey, uniformly fine dusty sand, without consistency. Rubbed between the fingers it feels rough, is without smell; surface broken, undulating, excavated, dry and loose, uncovered with grasses, and apparently arid.

Constituent parts in 200.

Water,	37
Fresh fibres,	1
Vegetable matter,	5½
Silex	135
Alumina,	11
Oxide of iron,	4¾
	194¼

No. 982. Soil of the neighbourhood, taken about 500 yards beyond the boundary at which the tea plants disappear. Colour, greyish black; surface, covered with grasses, moist, uniform, firm and solid. When rubbed between the fingers this soil possesses considerable cohereney and softness.

Constituent parts in 200.

Water,	52
Extractive matter,	5
Vegetable matter,	8½
Silex,	114
Alumina,	9½
Oxide of iron,	4
	193

I. No. 978, is the soil of the spot to which the tea is confined. No. 982 is that which surrounds the tea soil, and to which, if it were not inimical to the plant, we might expect the latter would be extended. As Cuju presents some tea trees probably thirty or forty feet high, measuring eight or nine inches in the diameter of their trunks, at the height of eight or ten feet from the roots, we may look upon it as an established colony; and of much older date than any which we subsequently examined. The portion of the forest in which the tea plants occur, presents no deviation from the level of the general plain. There are here no perplexing features, in local peculiarities of aspect or elevation, such as most of the other localities present. It therefore becomes necessary to compare the results of the analyses of the two soils, which appear to exercise so marked an influence on the main object of this inquiry.

II. Soils have been usually prepared for analysis, by exposing them to the air until they become moderately dry, disregarding the quantity of water they lose in the process. I have endeavoured on this occasion, to apply analysis to the different soils in the condition in which they occur in nature, where all is diversity, and no standard of exposure to evaporation from the surface, and filtering properties of subsoils is recognised.

III. The fineness and solidity of a soil, renders it less exposed to lose its excess of water by evaporation, than if it possessed a lighter texture. The pervious or impervious nature of subjacent beds; whether clays, sands, or continuous rocky masses; the depth of these from the surface, and their inclination with the horizon, are so many modifying principles of the nature and fertility of soils; chiefly however, from their operations in promoting, or restraining, the gravitation and evaporation of moisture from the surface.

IV. Such water as depends on peculiarities of the latter description I have denominated *free;* in contradistinction to that which depends on the nature of the soil itself, or what is commonly called water of absorption. Although the free water of any soil, will differ with the season, and with the state of the weather; yet if a few dry days be allowed to precede the selec-

tion of specimens, the uniformity in regard to the free water will be much more than might be expected.

V. In the present instance, the object was for the most part to discover what distinction exists between tea soils, and adjacent common soils; and for such comparative purpose, it was not necessary, nor did the circumstances of the journey allow me to observe any choice of weather, such as would have been desirable for the selection of specimens for a more abstract mode of inquiry; it being convenient, merely to select those specimens which it was intended to compare with each other, under equal circumstances with regard to rain, and other causes calculated to influence their moisture, independent of the structure of the soil itself, and of the beds on which it rests.

VI. In order to show the necessity of proceeding on these principles, it is only necessary to state, that I found the two soils of Cuju, after having been exposed equally to the air of a room, differ very little in regard to moisture; although in the state in which they exist in nature, the tea soil contained only $18\frac{1}{2}$ per cent. while the common soil contained 26 per cent. of water; yet both were taken within 500 yards of each other, on the surface of the same plain.

VII. The following explanation will account for this phenomenon, as well as for the other differences which analyses have detected between these two soils. An impervious bed of clay at an uncertain depth, interrupts the percolation of water; or in the absence of such bed, sands themselves containing particles of iron, become consolidated, infiltration is obstructed, and the surface, from having been arid, becomes moist. Vegetation then takes place, and the soil becomes bound with the roots of a succession of plants, which die, and form new constituents to its fertility.

VIII. Thus we can account for the black soil surrounding the spot on which the tea grows at Cuju, and the explanation suggests an opposite train of circumstances to account for the peculiarities of the soil and situation occupied by the tea plants, depending merely on the facility with which water is allowed to descend from the surface.

IX. Having thus determined the advantage of examining soils in the state in which they occur in nature, rather than in an artificial state to which they may be reduced by drying; it became necessary to separate free water from water of absorption. The first was estimated by the loss of weight sustained by exposing the soil to the temperature of boiling water; and the second, by the farther loss of weight occasioned by heating the soil in the ordinary way; but in the analysis of the two soils under consideration, this distinction was not made; and in the others, it would have been more accurate to have estimated the free water, as a physical property rather than a chemical constituent.

X. The Cuju tea soil, (976) contains 7 per cent. less water than that soil in which the plant does not grow. (982.) It contains $3\frac{1}{4}$ per cent. vegetable matter, in the state of dry woody fibres and impalpable powder; whereas the common soil, (982) contains $6\frac{1}{4}$ per cent. vegetable matter; but of this, a portion equal to about $2\frac{1}{2}$ per cent. of the soil is in the state of extractive matter. In the extractive we perceive the effects of excessive saturation, (VI. VII.) and it operates by affording coherency and solidity to the surface; while the remaining $3\frac{3}{4}$ per cent. of vegetable matters, united with the extractive, assists in retaining moisture at the surface, beneath which a putrefactive process must necessarily be taking place, in consequence of which the soil is rendered black.

XI. With respect to silex, which next to water is the principal constituent of these soils, (982) contains nearly 5 per cent. less than the tea soil. We find the extractive chiefly occupying the place of this deficiency of silex in the volume of the soil; for although there is a displacement of alumina, equal to about $\frac{1}{300}$ part of the soil, and of oxide of iron equal to $\frac{1}{800}$ part; yet it is not to such slight variation that we can ascribe the remarkable distinctions observed towards them by different forms of vegetation; and there is happily no necessity for rejecting those more obvious distinctions, which display themselves in the colour, consistence and moisture of soils, for the mysterious influence of minute chemical agents.

XII. It may, I think, be received as an axiom, that tea soils

differ from ordinary soils, and agree amongst themselves in retaining their mineral characters (whether derived from an oxide of iron, or from a peculiar sand) tolerably free from the discolouration of organic admixtures in a moist state.

XIII. Thus we find the plant disappears, on approaching the black soil at Cuju. It also disappears on the top of the mound at Nigroo, on approaching a similar black soil. This is also observed to be the case, on approaching the dark rich soil at the eastern extremity of the upper colony of Tingrai, whatever doubt there may be regarding the western boundary of that colony; and at Noadwar, the plant disappears on all sides where the soil degenerates from a clear yellow, to a brown or black colour, just as it does at Cuju.

XIV. An interesting observation resulting from these analyses is, that the vegetable matter in tea soils acts only as an absorbent of moisture, as appears from the fact, that where vegetable matter is greatest, alumina, the common absorbent principle of soils is least, all other circumstances being the same, and vice versa. Thus in the tea soil of Cuju, in which we have only $2\frac{3}{4}$ per cent. of vegetable matter, exclusive of a slight portion of recent fibres, we have $5\frac{1}{2}$ per cent. of alumina; but where vegetable matter amounts to 8 per cent. as in 1011, we find $3\frac{1}{4}$ per cent. of alumina.

XV. It is clear from these facts, that vegetable matters are not inimical to the tea plant, so long as they are not in a decomposed or decomposing state; that is, in general, so long as they do not discolour the soil, but exist in some degree as extraneous matters, or mechanical, rather than chemical agents, implying no other property than that the soil should be dry. It will be seen, however, in a subsequent part of this report, that under the peculiar climate of the tea plant, the requisite quality of the soil just noticed, must naturally be of rare occurrence; which will account for the manner in which the plant is distributed in spots, or distinct colonies, instead of being uniformly diffused with the common vegetation.

XVI. The two tea soils in which alumina abounds most, 1183 and 1013, are those of Gubru-purbut, and the summit of the

mound at Tingrai. In the one case the soil is raised 30, and in the other 20 feet above the level of the valley; in each the quantity of alumina is in proportion to the degree of insulation of the soil in regard to moisture, and the greater drainage to which it is exposed. In the one case the alumina amounts to 9, and in the other to 8 per cent.; although in no case where the plant is found on the plain, does the alumina in the soil amount to more than 6 per cent.; and seldom to above 4½ per cent. The narrowest inference we can draw from this is, that the same soil would not be suitable to the plant in every situation.

XVII. The last common constituent in these soils to be noticed is iron. The colour of soils affords a bad criterion of the proportion in which iron exists in them. Thus 1183 contains only 3 per cent of the oxide, yet it is of much brighter colour than 1009, which contains 6 per cent. Indeed the latter is only a pale greyish yellow, while the former approaches to orange. This may be owing to the metal being less oxidized, and also to the soil containing less vegetable matter in the one case, than in the other.

Without attaching any peculiar importance to the presence of iron in tea soils, much less to any particular form of the metal; yet the colour it generally imparts is likely to prove a valuable, though not an infallible guide in the selection of sites for plantations. Ferruginous colour whether it be yellow or orange, may be relied upon as characteristic of dry soils, tolerably exempt from chemical operations arising from organic impregnations which, under the high temperature and moist climates of tea countries are so likely to prevail. But light grey soils such as that of Cuju (978), as well as 1011 in the following series of analytical results are, under the circumstances in which they exist respectively, as salutary to the tea plant as any of the other soils examined.

28. From the foregoing enquiries it appears that the tea plant of Assam grows spontaneously under slightly distinct circumstances as follows.

1. In the level plain:—

2. On embankments or mounds somewhat raised above the

plain. Cuju, Noadwar and Tingrai are examples of the first, Nigroo and Gubru-purbut are examples of the second.

The first class of situations, are distinguished from the general plain, by a porous structure, and the peculiar character of maintaining a dry surface under exposure to excessive moisture; the second by a structure less porous than the first. In both, the plants are situated at the verge of inundations which prevail during the greater portion of the year on the adjoining lands.

The important peculiarity of these sites is, that they are less secure from inundation by their elevation than by their structure. Indeed the lower sites are scarcely raised more than a yard above the adjoining flat plains, which are exposed to inundations not merely during falls of rain, but also from the overflowings of the great rivers. But these circumstances, which are sources of fertility to the adjoining lands, appear to produce an opposite effect on the sites of the tea plant, thus causing the peculiar condition on which the presence of the plant in some measure depends. All soluble and subtile matters are prevented from accumulating in the soil of those sites, and are washed as it were from a filter into a loose sandy bottom—all vegetable and animal decompositions, and all chemical operations except the oxidation of particles of iron, are here prevented from taking place. Hence the characteristic colour of the generality of these soils already pointed out. Protected in Assam under the shade of dense forests and a gloomy and excessively humid atmosphere, (the latter the most indispensable of all conditions as I shall presently show,) the tea plant flourishes in its barren soil along the verge of rivers, lakes, and marshy lands.

Where the requisite porosity of structure is not afforded by subsoils, the defect may be overcome on the rounded summits of embankments, and on the declivities of small hills and undulations, such as those on which the plant appears to be cultivated in China:* and where these last are wanting artificial drains and trenches may be resorted to, either with the view of qualifying

* I shall have occasion to refer to authorities on this subject when considering the climate of the tea provinces.

an unfavourable soil for the reception of the plant in the first instance, or for supplying the want of suitable porosity.

In the more sandy rice districts, the small ridges which subdivide the fields may be increased in size, and each planted with a single row of tea plants, a practice which would seem to be followed in China although the erroneous notions hitherto entertained regarding the supposed mountain habit of the plant, prevented the example from having been before recommended.

There are however many spots of suitable structure in Upper Assam, that might be selected for new plantations; the most desirable might be at once chosen, while the old colonies should be carefully preserved for the supply of nurseries. This would seem to be the more necessary, as in case of the seed becoming exhausted by the injudicious treatment of the plants composing the original colonies, the difficulty that might arise in procuring a fresh stock from China might prove fatal to Assam as a tea province. From those tea seeds which were procured from China at an enormous expence to Government, few plants have been reared, and probably not one of those few will ever bear seed. The importance therefore of abstaining from officious interference with the original colonies must be evident. None of them are very great in extent, and it is possible to conceive that as they are all in retired forests some attempts may be directed to the transplantation of the trees in a more convenient but less appropriate situation, (as is almost sure to happen on such occasions if *convenience* be at all allowed to enter into our views) and thus exhaust, if not totally destroy the means of conducting more judicious experiments.

Little is to be expected from any attempts that can at present be made to manufacture tea from the uncultivated plant: but still as there is a small establishment on the spot for the purpose, consisting partly of Chinese, they might be employed in constant trials upon the leaves afforded by the different colonies in order to detect what the nature and degree of difference may be, between the products of the different soils as well as of leaves of different size. The mode of manipulation adopted with regard to each specimen, and how diversified, should be carefully noted,

and reports upon the subject forwarded to Calcutta by the person in charge; together with specimens of the prepared tea packed in leaden boxes containing those aromatics upon which some of the finer qualities of teas may depend.

Further observations may be derived from the following descriptions. The specimens of these and various other soils which are in possession of the Tea Committee may be submitted to a more elaborate analysis if necessary.

Soil No. 1009 (See Sec. 12, page 22.) Colour yellowish grey, structure intermediate between sand and clay, both being irregularly intermixed, the latter forming the matrix to the former. These parts are not uniformly blended, but the more clayey parts form nodular lumps surrounded by others of more sandy consistence. Tea plants few, of the first year's growth and sickly.

Constituents in 200 parts.

Free water,	20½
Water of absorption,	15
Vegetable matter,	11
Oxide of iron,	11
Alumina,	12
Silex in the state of fine dusty sand,	127
	196½

Soil No. 1010. Light brown colour, soft and fine, when rubbed in the fingers, without any tendency to clay or sand; surface undulating and higher than that of the last soil. Tea plants more numerous.

Constituent parts in 200.

Free water,	23
Water of absorption,	23½
Oxide of iron,	6
Vegetable matter,	11
Alumina,	9
Silex, fine and dusty,	122
	194½

Soil No. 1011, from the foot of the mound, Tingrai. (See Sec. 13. page 22.) It is a loose grey sandy soil containing particles of mica, and

appears to be the same as 1009, but subject to the action of the water from the mound percolating through it as a filter. The specimen was selected from the roots of a large tea plant, but smaller plants are numerous, healthy and flourishing in it.

200 parts afford

Free water,	22½
Water of absorption,	3
Vegetable matter,	16
Oxide of iron,	6
Alumina,	6½
Silex in the state of coarse sharp sand and dusty matter.	130
	194

Soil No. 1013, from the top of the mound Tingrai, (See Sec. 13. page 22.) Colour yellow ; substance light and dry; soft when rubbed in the fingers. Structure very loose, abounding in reticulate fibrous roots which cause the surface to yield under the feet. Upper surface to the depth of an inch covered with dried leaves and other loose vegetable matters. Tea plants very numerous, that is to say, a plant occurs in every three square yards at least.

Constituents in 200 parts.

Free water,	26
Water of absorption,	20½
Corbonate of lime ?	1
Vegetable matter,	9½
Oxide of iron,	9
Alumina,	16
Silex in the state of impalpable powder.	114
	197

Soil, No. 1176. Noadwar soil. See Sec. 15, page 23.

200 parts yield

Free water,	25
Water of absorption,	19¾
Oxide of iron,	13
Vegetable matter,	8½
Alumina,	9½
Silex,	120¼
	196

Soil, No. 1183. Gubru-purbut. See Sec. 20. page 25.

200 parts yield

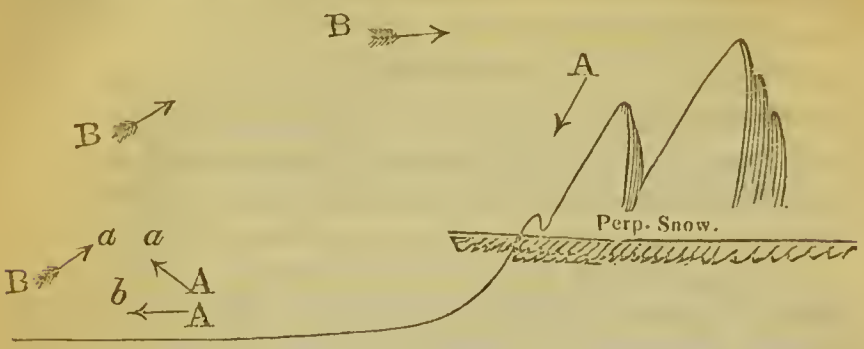
Free water,	23
Water of absorption,	10
Vegetable matter,	9
Alumina,	18
Oxide of iron,	6
Lime,	1
Silex,	132
	199

Note.—The water of absorption in this last soil, appears to be less than the quantity of alumina in it compared with that of the other soils would lead one to conclude. But the method adopted to distinguish between the watery part was very imperfect. The standard of boiling water was resorted to in preference to slow exposure to the atmosphere in consequence of the absorbent power of air differing so much in India in different seasons, and these analyses were made during the rains.

Part III.—*Climate.*

29. The wind in Assam is N.E. at all seasons, and the whole valley lies in the direction of its current. Descending from the Himalaya the air derives an impetus from its low temperature, and consequent greater specific gravity than the heated westerly wind. It is not meant that the air in the upper atmosphere in contact with the snow is heavier than the lower strata in the valley, which would be contrary to certain well known laws; but merely that the air in the vicinity of the mountains above the line of congelation, is rendered specifically heavier than the general air of the same altitude, in consequence of the heat absorbed from it by the snow. It consequently sinks, causing a motion in the warmer air to occupy its place. Thus an upper current is formed while the lower one descends into the valley where its diminished temperature renders it sufficient to overcome the heated land winds which enter from the west, by the great defile of the Bramaputra.

The annexed diagram will render these phenomena better understood than mere description.



The three arrows AAA represent the local current, and BBB the exhausted S.W. wind as it arrives from the open plains of Bengal.* The mountains on the northern and southern sides of the valley, and the irregular accumulation of vapour must produce a corresponding variation of the currents near the surface of the valley at *b*, the situation at which the opposite forces are supposed to meet. This point will vary of course according to the relative intensity of the two currents.

30. During those months when the westerly winds have greatest power, and the influence of opposing currents from the N.E. extremity of the valley most diminished, in consequence of the disappearance of a larger proportion of snow in that direction; the westerly winds then extend with lessening temperature and velocity as high as Bishenath in Middle Assam, beyond which they are seldom known to reach; nor is their power even there sufficient to overcome the influence of the N.E. current, more than for a few days at a time during the hottest days of April and May.

Throughout the cold season, dense vapours arise from the Bramaputra about day-light, and continue to increase until 8 A. M. when they begin slowly to ascend. They are then drifted before the N. E. wind, which from the diminished heat of the valley now amounts only to a gentle movement, the direction of which is

* See Fig. 2. Plate I.

modified by the action of the sun's rays on the upper stratum of mist, causing a more or less powerful dissipation, and exciting a movement in the general mass towards the side on which this action is taking place. The whole of the vaponrs are thus attracted towards the south, where unless entirely dispersed by noon, their broken masses linger on the northern face of the Naga mountains, receiving daily fresh accumulations, until they are precipitated in heavy rain, seldom however before they have served as an impenetrable canopy to this side of the valley for several weeks.

This tendency of the mists to occupy the south side of the valley, is an interesting point if considered with reference to what I have already stated regarding the absence of the tea plant on the northern side.*

The plains on the northern side of the Bramaputra, may indeed be considered generally to enjoy two hours more sunshine daily, during the cold season than those on the south, a circumstance which is of itself calculated to influence vegetation, and cause a difference in this respect between the two sides of the valley.

31. With regard to the cause of these mists, it would be easy to say that they arise from the moisture of the forests ; but if this were all, they should appear after sun-set when the heat of the day is first withdrawn; the loss of temperature would then cause a condensation in the lower atmosphere, which is not the case in Assam ; nor do the mists first make their appearance in the forests, but on the river, and on such parts of it as are shallowest and most languid in current.

I attended as closely as I could without neglecting other equally important matters, to these peculiar phenomena, and the only conclusion I could come to from the observation of simple facts was, that they arose from the difference of temperature between the water of the Bramaputra and the air, which amounted to a mean difference of 15° Fahr. during the month of December. Throughout that month, in our progress up the river from Gowahatti to Suddya, I found the water at sun-rise vary

* See page 16 ; also Fig. 1, Plate I.

from 55° to 56° Fahr. and the temperature of the air at the same time, from 38° to 42° Fahr. This difference causes the water to give off more vapour than the air can hold suspended in an invisible form; partial condensation immediately ensues, and the sensible vapour is then seen curling over every portion of the river, just as steam presents itself to view ascending from the surface of heated water.

32. Those high altitudes by which Assam is surrounded, occasion a rapid abstraction of heat during the nights of the cold season, in which the waters and the air participate unequally, as conductors of different powers. The latter consequently retains a higher mean temperature than the former, and assists during the cold season to check excessive diurnal variations. On the other hand, in the hot season, when the radiation of heat from extensive wastes of sand is prevented by the freshes which cover them, and the volume of water increased, as well as the rapidity of the rivers by the melting of the snow; the rivers then present a temperature much beneath that of the atmosphere whose heat they now contribute to lessen, just as they promoted an opposite effect during the cold season. Nor is this influence of large bodies of water upon climate confined to Assam; it applies equally to all great valleys similarly situated, and especially to those inland provinces of China whose productions are so similar.

From what I could learn regarding the temperature of the hot season, it would appear that 82° Fahr. at Suddya, is considered as excessive as 96° in Calcutta; and although the quantity of rain that falls during the year may be supposed from a combination of circumstances, to be much in excess of what falls in Bengal, yet there is reason to suppose that during the months of July, August, and September, the quantity in Assam may be no greater then elsewhere; the absence of any season of perfect drought being the peculiar feature of the climate. If however the theory by which I have endeavoured to account for the peculiarity of wind, during the S.W. monsoon be correct, it is difficult to

conceive that clouds and showers should not be frequent, or at least occasional during the months of April and May.*

33. From these general observations on the climate of Assam, we may venture to infer that in regard to heat and moisture, it possesses many peculiarities when compared with the open plains of Bengal.

Looking down from the Kossia mountains into the valley, in November, it presented the appearance of one vast lake, from the sheet of vapour under which it was concealed for several hours daily.† While ascending the Bramaputra in December, the weather was generally dark and gloomy with some rain. During the time we were in the forests, which embraced the greater portion of January, we seldom saw the sun; and the early part of the month was chiefly wet. February, and until the middle of March, was generally wet; nor have I often witnessed even during the regular rainy season, heavier or much more frequent falls of rain than took place in Assam at this period. On the most moderate computation, I do not think we could reckon the quantity of rain that fell during the three months above mentioned, at less than 15 inches; yet during the same period in Calcutta, I find on reference to PRINSEP's Journal, that only 2 inches of rain fell—one shower only having taken place in December, January being dry throughout, and February affording but two days on which any rain whatever fell.

Note.—The following, which is all I can say on the subject, may afford some elucidation of the climate during the hot season resulting from the collision of the S. W. monsoon with the local N.E. current in Upper Assam.

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* On two winds of different temperatures and differently saturated coming into contact, the result would be the formation of a cloud or the precipitation of rain according to the proportion of moisture contained in the warmer vapour. See PROUT's *Bridgewater Treatise*, 292.

† This was sometimes observed even for several days, and may be considered to have been actually the case during the greater part of the two following months, but being then in the valley we could not perceive it otherwise than by the shade. The effects of these clouds upon vegetation, and in checking extremes of temperature, may be conceived from the circumstance that when they were first observed from the Kossia mountains, a keen N.E. wind blew daily, and from which the valley was quite protected by the vapour.

On the morning of the 22d March, a severe storm of thunder, wind and rain took place. It approached rapidly from the western horizon, which presented the most lurid aspect; yet at Noagong, about 30 miles east of Bishenath, (in the direction of the storm,) I afterwards learned it was the eastern horizon that presented the peculiar aspect observed at Bishenath in the west; so that the storm must have originated in the intermediate space, nor was its range on the east of Bishenath to all appearance more extensive. The weather continued cloudy till the 27th, and on the 29th another storm took place; on the 4th of April a third; but as I then finally quitted Assam, I had no farther opportunity of making observations.

Having now described the condition of the tea plants in Assam, it may be desirable to offer a few remarks upon their situation, compared with what is said by various authors to be the case of the plant in China.

34. If we take Kiang-nan and Kiang-si, as instances of two of the tea provinces of which we have the best information, we find their resemblance in all great leading features to Assam, very remarkable. Lofty mountains extending parallel to the S.W. and N.E. monsoons, and including extensive low vallies, whose lands are inundated by great rivers are features, common alike to the three provinces. We have no direct evidence to guide us to any conclusion as to the quantity of rain that may fall annually in either case, but according to Davis* the month of May at Canton is very wet.

After experiencing the droughts of the open plains of China, during the months of August, September, and October, each embassy, the one in 1793, and the other in 1816, encountered rains in November; the first on approaching the Poyang lake, and the second as soon as it entered the mountains in which the lake is situated. Yet Davis informs us, that at Canton rain seldom falls during the winter months, and that for a series of sixteen years the average fall of rain at Macao, in November, amounts to little more than 2 inches.† Hence, perhaps, we

* *General Description of China*, ii. 353. † *Ibid.*

may conclude that the mountain provinces north of Canton, are at no season exempt from rain; in proof of which I may quote the assertion of all, that their fertility is proverbial.* If we compare these facts with what I said of the climate of Assam, we may infer that a most striking similarity exists between that province, Kiang-si, and Kiang-nan with reference to humidity, but this will be further shewn to be the case.

The tea provinces of China all lie within the parallels of 25° and 31° N. lat., within which a group of mountains is extended from the Thibetan Alps on the west, to the shores of the Yellow sea, consequently crossing the course of the monsoons, whose vapours they may be supposed from all similar analogies to precipitate. There is here no general elevation of the land, no elevated plateau. The Po-yang lake which we are informed by GROSIER is occasioned by the confluence of four great rivers, is nearly an hundred leagues in length, "and subject like the sea to violent tempests." It is three hundred miles distant from the sea; and the Tong-ting lake still larger, is also situated in the midst of the tea province of Hou-quang, and is 200 miles more inland than the Po-yang. These lakes repose in vallies scarcely raised above the level of the sea, are united by navigable rivers and surrounded by low alluvial plains, subject to inundation, or at most only raised above the influence of ordinary floods.

The greatest river in China flows through these vallies, and though it takes its principal source in Yu-nan, only 400 leagues from the sea,† with scarcely a greater hydrographical basin than either the Ganges or Bramaputra, yet appears to transmit a volume of water equal to both; so that we must ascribe its size, as well as that of the two great lakes above mentioned, to the physical peculiarities of the tea provinces, and especially to

* "The abundance of Kang-si could furnish all China with a breakfast; but the province of Hou-quang alone could supply enough to maintain all its inhabitants."—GROSIER, ii. 69.

† GROSIER states Yu-nan to be the source, but more recent writers have extended it further.

the direction of the mountains in this part of China with regard to the monsoons.*

We are told by Sir GEORGE STAUNTON, that the waters of the Pei-ho dry up in a great degree, on the approach of winter; which he ascribes to the diminished energy of the sun in melting the snow at its source.

This must be the case of all great rivers, which depend on periodical causes for the supply of their waters, as is instanced by the Ganges, and Bramaputra; but the Yang-tse-kiang seems to undergo but slight remission, as proved by the difficulty experienced by Lord AMHERST, in making any progress against its stream in the middle of November, which they compared to the sea. The rivers on both sides of the hills, crossed by Lord MACARTNEY's embassy, when approaching the Po-yang lake, also in November, were so swoln by rain then falling in the tea provinces through which the embassy was at the time passing, that great damage was occasioned by the inundations.† But whether the great lakes and rivers of this part of China, be supplied from the atmosphere by the causes to which I have ventured to ascribe them, or not, I have no doubt it will be acknowledged that so large a surface of the vallies cannot be covered by waters, and excluded from prevailing winds by lofty mountains, without producing some such local influence on the climate as I have pointed out to be the case in Upper Assam.

As we have seen in Assam, clouds and mists will be the consequence‡ where low marshy lands are surrounded by mountains: but where these last are absent, as in the Sunderbunds of Bengal, although swamps and marshy lands may prevail, and the sun be ever so hot, the sky will continue clear, which is precisely the case in the inundated but open plains of Chang-tong; and

* The Kau-kiang river, which is well known as forming part of the line of water communication from Canton to Peking, rises and disembogues in the same province, with a hydrographical basin scarcely larger than that of the Thames, yet appears to transmit an enormous quantity of water, its breadth being according to BARROW 500 yards before it enters the Po-yang lake.

† BARROW, 532. ‡ See note to page 43, Sec. 33.

it is a remarkable fact, that these plains which are called expressively by BARROW the "country of inundation and drought," (and in which Father GROSIER tells us it seldom rains, and although the lands are inundated, the sky is clear) form the northern limit of the tea plant in China;* thus indicating the want of a more gloomy sky and humid atmosphere; for as all the plains are alluvial, soil and structure must be pretty much the same, whether in the open plains of the Yellow river, or the vallies of the Yang-tse-kiang.

35. Light being known to exercise considerable influence on vegetation, I am not disposed to venture an opinion as to whether it be to avoid that, or to obtain moisture that the plant resorts to vallies at the base of lofty mountains, and to the vicinity of lakes and rivers; but certainly there is no quality of the atmosphere of which it displays more independence than temperature, if we may judge from the wide range of latitude in which it is said to be indigenous.† Not that I consider that the plant in Assam affords any new argument on this score; on the contrary, it will appear from the following comparison that the assimilation of climate in respect to temperature, between Assam and the tea provinces of China, is much greater than some may suppose.

Mean temperature on the Po-yang lake, at 7 A. M., from the 20th to the 24th November, Lat. 30° North, 48 Fahr.‡

Mean temperature on the Bramaputra 7 A. M. for the month of December, while passing from Gowahatti to Suddya, 47. 01° Fahr.

These observations in both cases were made in boats, but as the metereological observations of the embassy, preserved from the wreck of the *Alceste*, do not extend beyond the 24th of November, and we did not commence our journey on the Bra-

* Mr. ROYLE, on the authority of Mr. REEVES, mentions that the tea plant is cultivated as far as 36½° North in certain mountain tracts on either side of the great plain, which affords some reason for expecting that under the humid atmosphere of mountain vallies, the plant may be found as far north in China as it is known to exist in the insular climate of the isles of Japan.

† Royle mentions its habitat as far south as 17° N. Lat, and Dr. ABEL (223) that it extends over the isles of Japan to 45° N. Lat.

‡ ABEL'S *Journey in China*, 109.

maputra until the first of December, I cannot unfortunately, draw any more direct comparison. It does not, however, appear from the observations occasionally made by Barrow, or by Ellis, on the thermometer during the month of December, that the mercury underwent on the Kan-kiang river any sudden, or greater depression compared with the previous month on the Po-yang lake, than is usual at Canton, where the difference of temperature between November and December, amounts to 8° Fahr.

Even these data, slight as they are, will help to prove that the tea provinces of China participate little in the extreme climate of the northern plain; and that the winter experienced by those tea plants which were seen from Lord Amherst's boats, on the 5th November, under cultivation and in full flower;* as well as those seen on the 8th of the same month, together with those which were seen on the 18th near the Po-yang, cannot be very different from that which is enjoyed by the tea plants in Assam, where they appear under similar general and local circumstances, except that they are not cultivated.

36. The small size of tea plantations, even in those provinces most celebrated for the production of the article, was a source of surprise and disappointment to all travellers who had an opportunity of inspecting them, and although a small individual plant, was on one occasion found by Dr. Abel, quite detached from any of its species, yet on every other occasion on which tea has been found in China, wild or cultivated, numerous plants were congregated together, so as to constitute little colonies, seldom more extensive than those in Assam.

This circumstance appears to have led Sir George Staunton, and Dr. Abel, to undervalue such plantations as happened to lie in their way, and to imagine the existence of others more extensive, but which they appear to have had no opportunity of in-

* Ellis's *Jour.* Lord Amherst's *Emb. to China*, ii. 49. The circumstance of these plants having been in flower in November, is a proof that they do not hybernate or sleep during winter. Our Assam plants in January when first seen were losing their fruit, so that the period of flowering would seem to be the same in both countries—a proof of the similarity of their climates.

specting—an error, if I may venture so to name it, the more natural, when we consider the vast quantity of tea that is annually exported from China; but we may rather suppose the number of small plantations to be very great, than that any of them are extensive.

37. The only locality in which Lord MACARTNEY's Embassy witnessed the tea plant, was in the province of Che-kiang, near the city of Hang-tcheon, N. Lat. 30° 20′. On the low bank of the Cheng-tong river, where it was found on the "sides and tops of earthen embankments, dividing gardens (query, for restraining inundations) of oranges"; and Sir GEORGE STAUNTON says, of this tea "that it is seldom sown in flat marshy lands, which are reserved for rice."*

BARROW farther observes that "it was used for hedge-rows, to divide gardens, and not particularly cultivated for its leaves;"† but this may be doubted. He also states that the plains intervening between the rivers and the mountains, were planted with sugar-cane, and that an estuary in which the tides ebb and flow, was observed in the vicinity.‡ Sir GEORGE STAUNTON describes the weather here in November as dark and cloudy, although the "thermometer was seldom observed so low as 48° Fahr.," which he ascribed to the "winds being hemmed in between mountains and accelerated in their motion."§ BARROW remarks that the mean temperature of this province, in the middle of November, was from 56° at sunrise, to 62° Fahr. at noon. "It abounds in lakes and is intersected with rivers and canals," he says, "like Kiang-nan." Speaking of the treatment of the silk worm, he says, it is here necessary "*in fine weather* to expose the young to the sun," from which it would seem, as if the latter were a less common occurrence in Che-kiang than in the plains of Peking, where they had nothing but sun from their arrival in August until they entered the mountain vallies of the latter province in November.

38. The first tea plants that were seen by Lord AMHERST's Em-

* Lord MACARTNEY's *Embassy*, ii. 464. † *Travels in China*, 530.
‡ Ibid, 529. § Lord MACARTNEY's Embassy, vol. ii. p. 469.

bassy, were near the village of Ta-tung, under the 31° N. Lat. in the great valley of the Yang-tse-kiang river, within a walk of the boats. Barometer on the river, 30°13.' Thermometer, 63° Fahr. Leslie's Hygrometer 58°* Ellis speaks of this plantation in the following words: "Our walk," (towards a lofty range of mountains rising in the distance from undulating plains,) "led us through a valley where we saw the tea plant for the first time. It is a beautiful plant, resembling a myrtle with a yellow flower. The plantations were not here of any extent, and were either surrounded by small fields of other cultivation, or placed in detached spots.† Dr. Abel (*who was not with the party*) says this plantation is on the side of a hill."‡

The geology of the country approaching Ta-tung is thus described by Ellis; "A sandy beach covered with pebbles, resembling a sea shore. The pebbles belonged evidently to hills rising immediately from the beach and composed of similar pebbles imbedded in loose sand. Oaks not growing beyond the size of large shrubs, and a small species of fir covered the sides of the sand hills."

39. Three days after leaving Ta-tung, the boats were anchored at an island in the vicinity of several smaller islands, in the great river near the village of Woo-sha-kya. "There are," says Ellis, "evident traces on this as on the other islands of their being at times inundated, if not wholly submerged; I crossed the water and took a ramble in the interior, more remarkable for the facility with which a stranger might lose himself, than for any other circumstance. As far as the eye reached there was a succession of hollows and elevations; the highest points with clumps of trees. The cultivation consisted of cotton, buck-wheat and beans; and one plantation of tea was met with in full flower."§

It is worthy of remark, that Dr. Abel who was still unfortunately confined to his boat by sickness, places this as well as the former plantation, (neither of which he could have seen,) *on hills.*

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*See Dr. Abel's map of the Yang-tse-kiang and Po-yang lake.
†Ellis, vol. ii. p. 46. ‡Tour in China, 164. §Ellis, vol. ii. p. 51.

40. On the 18th November, the tea plant was again found by Ellis, who appears to have been indefatigable in his excursions. The embassy had now reached the Po-yang lake, expressively denominated by Barrow the "*sink of China*," in consequence of the low, marshy lands by which it is chiefly surrounded. It is described by Ellis as sixty miles in length, exclusive, I presume of an equal extent of deltas where great rivers enter it on the South;* and its breadth could not be determined in consequence of the number of islands with which it is interspersed. A lofty mountain called Sew-sham, described by all as stupendous, and bold feature ascends from the marshes at the northern extremity of the lake, and which, with other high altitudes with which it is connected, may be supposed to contribute to the condensation of vapours which are constantly rising from the waters and marshes at its foot, and here observes Ellis "the tea plant was again found, *but still in small patches.*" The Sew-sham had snow on its summits when first seen, but which melted, the following day under the rays of a bright sun.

41. If we consider (37 to 41,) the only situations in which the tea plant has been seen, by the two British Embassies; and the descriptions derived therefrom, by those who inspected them, reduced simply to what was witnessed, I feel assured that no one will agree, to the full extent, with the conclusion of Dr Abel which I am about to quote. "It appears," says he, "from every account given of the tea plant, that it succeeds best on the sides of mountains, where there can be but little accumulation of vegetable mould; our opportunities of seeing the tea plant were few, but they were all in favour of this conclusion."

The above conclusion, as well as his recommendation of Table mountain at the Cape, shew how essential he conceived high altitudes for the cultivation of the plant; and as his authority might be cited in favour of an opinion that the plant is out of place in Assam, I have thought it necessary to examine the degree of experience on which this opinion rested. If any thing further

* Grosier as I have already quoted, states the lake to be nearly one hundred leagues.

remains to convince us, that the tea plant of Che-kiang (37), and Kiang-nan (38 to 40), is an inhabitant of low, moist inundated situations, where it grows on mounds, embankments, and spots of peculiar geological structure, it is the fact of its only having been found by the embassies, while in boats on the great rivers and lakes. Lord MACARTNEY's embassy had an excellent opportunity while crossing the ridge that separates two of the best tea provinces, Che-kiang and Kiang-si, for determining the character of the plant, were it an inhabitant of that tract; yet it was not met with in this part of the journey, which lay too, almost in a line across those hills marked in Dr. ABEL's map as green tea districts: nor did this, or the subsequent embassy find it on crossing the Me-lin mountains, although Dr. ABEL found it before quitting his boat, at the northern foot of the mountains, on the Kan-kiang river.

42. The *Comellia olifera*, which we are told by Sir GEORGE STAUNTON grows in stony lands on "the sides and very tops of mountains," from its resemblance to tea, and from the circumstance of its bearing the same name among the Chinese,* may have been taken for it by the Missionaries, in some instances; thus giving rise to erroneous accounts regarding the habits of the latter. Another reason which may have contributed to the belief that high altitudes, (out of China,) are necessary for the cultivation of the plant, is the supposed lower temperature of China, generally during winter, than other countries in the same latitude; but there is reason to believe that this peculiarity is confined to the plains of Peking, and to certain open tracts, exposed to dry winds. It is one of the properties of a humid air to be little liable to sudden transitions, or great extremes of heat and cold; and we certainly find in the careful perusal of what has been published on the subject, a combination of all that is calculated to promote such a condition of climate in the tea provinces.

* General Description of the Empire of China, by J. F. Davis, Esq. F. R. S. vol. ii. 352.

† Lord MACARTNEY's Embassy, vol. ii. p. 467.

43. The maritime province of Fo-kein bears few features in common with the other provinces, to which Assam has been compared; and the teas here produced are different, being what are called *black*. It may probably be found that moderately elevated coasts, under certain circumstances, afford climates analogous in some points, to those of deep vallies furnished with extensive waters, under circumstances favourable to the production of vapours.

44. The tea plant is in China an associate of certain families, some, perhaps the most peculiar of which, also accompany it in Assam:* but the flora of the latter is deficient in pines, an order which some may suppose to be characteristic of the climate in which the tea plant ought to be cultivated. This may also have led to the general impression that high altitudes were requisite for the above purpose.

The only way in which we can distinguish between such plants as are accidentally associated, and those whose local concurrence depend on some peculiarity in which they are naturally concerned, is by enquiring into the degree of affinity that may exist with reference to their habits.

From the tea plant being indigenous to an extensive range equal to 28° of latitude, with little reference to altitude, we may suppose temperature to have little influence on its distribution. But in order to avoid exaggeration, I will confine my observations to the limits within which it is known to be cultivated with success; that is, from Fo-kien in the 24° N. Lat. to Meaco in the isles of Japan, in about 35° N. latitude. In these situations, eleven degrees from each other, the tea plant is cultivated with equal success, at an equally inconsiderable elevation above the sea. Now supposing these tea plants were endowed with the habit of pines, those in Fo-kein would then require to be 3,420

* See GRIFFITH's new genus of *Homamelideæ* Asiat. Res. vol. XIX. 99. The habits of his *Sedgewickia Crasifolia* compared with *Homamelis Chinensis* (ABEL's *Journey in China*, 375) is of great interest in this enquiry.

feet above those at Meaco.* In Lapland under the 68° N. Lat. pines are capable of bearing a mean temperature of 31° Fahr. at an elevation of 957 feet. In the Alps, under the 44° N. Lat. they disappear in the mean temperature of 35° Fahr. at an elevation of 5,850, and in Mexico under 19° N. lat. pines are incapable of supporting a lower temperature than 44° Fahr, at an elevation of 13,000 feet.

Thus it seems that as they approach the equator, pines become less capable of bearing a low temperature, than in northern latitudes: but in consequence of the height to which they must ascend, the point is left in doubt whether it be the greater humidity, or the greater rarity of the air of their situation in low latitudes, that occasions this aberration in their nature with regard to temperature. If humidity occasion it, as it probably does, their inferior limit throughout the extent of their vast zone, will be liable from the same cause to frequent aberrations, according to the moisture of climates. And thus the humidity, and uniformity of temperature in the tea provinces of China, would seem to favour an unusually tropical development of their region; so that the presence of the *pinus massoinana* or what ELLIS calls a "small species of fir, on the sides of hills" little above the level of the sea in the 30° N. latitude, is not to be taken as an incontestible proof of the low temperature of the provinces of China as has been generally insisted upon, especially as the other productions of the soil such as rice, sugar-cane, cotton, bamboos, and oranges, along with which the tea plant has been always found, are satisfactory evidence of a contrary nature.

45. It is clear from the object of the foregoing report, that every branch of natural history is equally concerned in it, and that while enquiry cannot possibly embrace too much, or be too closely directed to every object presented by the physical geography of the country, it would be comparatively useless if restricted to the mere examination of the tea plant and soil, from

* On Mount Perdu, lat 44° N. pines are found at an elevation of 7,800, while in Lapland 68° N. they disappear at 957 feet. See LINDLEY's introduction to Botany, 481.

which alone we could scarcely draw a conclusion that would prove satisfactory, because we know comparatively nothing of the operation of soils upon vegetation.

The study of natural history is now no longer confined to the external characters of species, or the business of the naturalist who travels, to the mere accumulation of specimens; but is extended to the habits and affinities of entire groups that are not to be examined except upon the spot, or collected, but in the mind of the philosophic naturalist, who ought to be capable of viewing them in all their relations to each other, taking care however that his general views are based on an intimate acquaintance with the details of species.

The affinities and analogies of groups and families have already been established in ornithology by the genius of our countryman SWAINSON; so that this class already presents a beautiful chain of groups, diverging not merely into each other, but also into other classes of animals by such links as the Cassowary, a bird that cannot fly nor swim, and the Grebe on the contrary, whose feet as well as wings are only constructed to perform the office of fins. By examples of this kind, he points out how the inhabitants of the air, such as the swallow, whose wings are formed for its only support, pass by a succession of steps into those classes whose habits are terrestrial, as well as into that class which is excluded from "the elastic air and consigned", to use the words of CUVIER "to eternal silence."

These connections once established between natural families and classes, it will then become the business of philosophy to trace their existence between the different kingdoms of nature. Those which connect the two organic kingdoms have been long known to exist under the name of Zoophytes; but those links which connect organic, with inorganic nature are more obscure, although the mutual effects of these opposite conditions of matter upon each other, are of the most familiar occurrence, such as the influence of soil upon vegetation, and of peculiar rocks in the development of certain diseases; but as the latter is foreign to the objects of this report, I merely refer to it as one

of the probable dependencies which every where exist between the various objects of the creation.

I have already hinted at the importance of Zoology as calculated to assist in casting a light upon the peculiarity of climates, and as affording data for the comparison of one with another. If we consider how instrumental birds for instance are, in the dissemination of plants, how essential certain seeds and certain flowers are to the support of certain animals and insects, we perceive at once rational grounds for expecting to be able to trace an accordance between the vegetable productions of our country, compared with those of another, when the Zoology of both agree in particular features; and hence the application of these principles to the present object.

The preponderance of Malayan over northern forms in Assam, notwithstanding the lofty range of mountains which might be supposed to contribute to an opposite effect, and rather attract animals towards the South is an interesting indication which will be at least corrected, if not confirmed by my collections. But though lofty ranges of mountains afford climates equal to certain proportions of higher latitudes, yet animals in order to enjoy such insulated positions would be confined to ridges only, without being able to indulge their natural wandering propensities except under exposure to the heat of vallies. On the other hand, animals of the South may extend considerably beyond the strict limits of their geographical sphere, by taking advantage of the shelter of mountain chains, and thus experience no very remarkable change of circumstances from what nature intended they should bear; and in this way we may account for many of the peculiarities of the natural history of Assam, which are not confined to the tea plant, but extend to other species perhaps equally restricted in their habitat. In the animal kingdom the interesting genus Ciconia of Cuvier presents two distinct species of crane as large as the adjutant (ciconia dubius) and which are quite unknown in Bengal or any other part of India. I have already adverted to a large squirrel as peculiar to Eastern Assam, and although it is there extremely common, not an individual has been found in Lower Assam; or even

beyond the Northern limit of the alluvium. From thence it is probably extended to the eastward, but occurring only in vallies affording similar vegetation, and consequently possessed of similar peculiarities in structure and climate to Assam. The Simia Hylobites agilis Duvaucel a species of ape, appears from the observations of Dr. HARLAN to be almost equally limited to Assam and its vicinity.*

If from the lower animals we now direct our attention to the various tribes of man which compose the several nations by which Assam is surrounded, we shall find the same line of demarcation interposed between the eastern and western varieties of this species, as already observed with reference to other beings. The Singphos, or people who inhabit the Dupha mountains display in the construction of their face, the light colour of their skin, their manners and ingenuity, the almost pure Mongolian or Chinese race. The Nagas on the contrary, who inhabit the vast mountainous country extending from Assam to the frontier of Birma, incline, (if I may judge from the few individuals I had an opportunity of witnessing), to the most degenerate of Caucasian Hindoos, but without a trace of their religion. Yet it is a curious fact, that the Kossia tribe which occupies the Western extremity of the same mountain-group, are a well marked branch of the Mongolian race, which here appears to have extended to the extreme point where the climate and natural productions cease to resemble those of the countries from whence they were derived; and thus surrounded by powerful Caucasian nations, and intercepted by the Nagas, this insulated people appear not merely to have maintained their independence ; but the purity of their blood, as well as distinct customs, language, and religion.

In this way we derive from Zoology additional aid in support of those views which the sister sciences afford, and are taught to look upon the tea plant in Assam, thus associated with the natural productions of Eastern Asia, not as an alien estranged

* It is described in his Medical and Physical Researches, Philadelphia, 1835, page 10, as a new species under the name of Simia hoolock.

from its own climate, but as an indigenous plant neglected it is true by man, but in the full enjoyment from nature of all those peculiar conditions on which its properties will be found under proper management to depend.

THE END.

ERRATA.

Page 3, line 2, *for* indentified, *read* identified

— „ — 13, *for* subappennine, *read* subapennine

— 51, — 10, *after* as, *insert* a

— 52, — 16, *for* comellia, *read* camellia

— 53, — 18, *for* naturally, *read* mutually

— Note to this page, *for* Homamelidaœ sedgewickia, &c. *read* Hamamelideœ, Sedgwickia, Hamamelis

— 57, line 5, *for* Hylobites, *read* Hylobates.

Pl. II.

fig. 1.

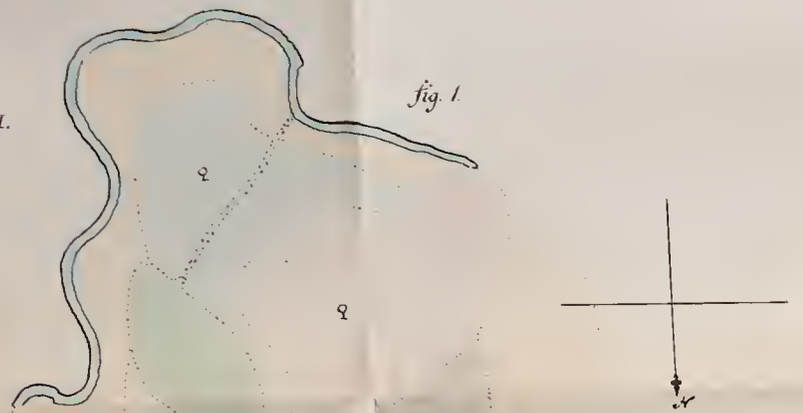

fig. 2.

Map and Section of the surface of the Tea colony near the village of Nigroo.

Pl. III.

fig. 1.

fig. 2

J M C. del.

Map and Section of the surface of the Tea colony Noadwar

Light Blue, represents water.
Green, Ponds, and occasional waters
♀ Tea plant.
N.B. different soils are represented by their respective colours.

Pl. IV.

fig. 1.

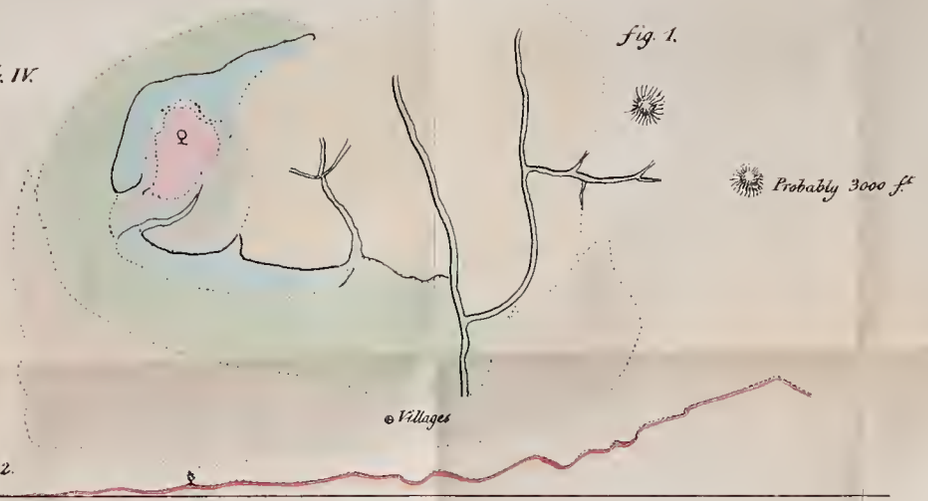

fig. 2.

Map and Section of the Tea colony at Gubroo Parbut at the northern foot of the Nâga Mountains.

Pl. V.

fig. 1.

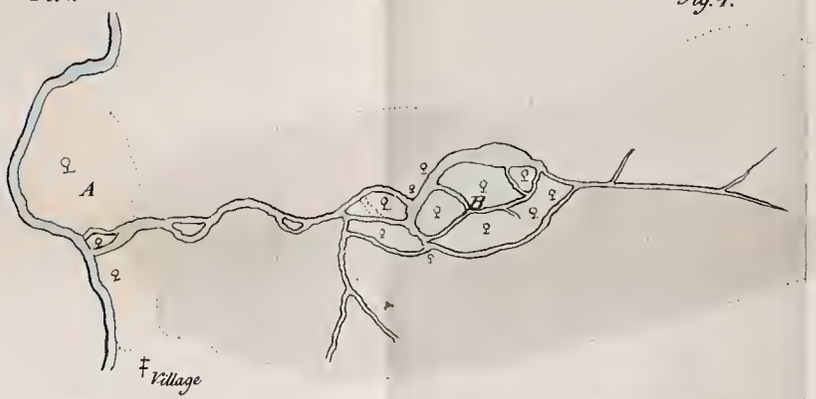

fig. 2

Map and section of the Tea colony at Tingrai. A lower and B the upper locality.